with time. This is most likely due to the alignment of fibers in the direction of shear.

FIG. 26 is a graph of the skin thickness as a function of water content for a formed product of the invention, showing that as the water content increased in the moldable mixture, the skin thickness decreased in the final product. FIG. 27 is a graph of the average internal cell diameter as a function of water content for a formed product of the invention, showing that as the water content increased the cell diameter also increased.

The present invention may be embodied in other specific forms without departing from its spirit or essential characteristics. The described embodiments are to be considered in all respects only as illustrated and not restrictive. The scope of the invention is, therefore, indicated by the appended claims rather than by the foregoing description. All changes which come within the meaning and range of equivalency of the claims are to be embraced within their scope.

What is claimed and desired to be secured by United States Letters Patent is:

1. A starch-based composition for molding into an article having a starch-bound cellular matrix, the starch-based composition comprising water, a starch-based binder in a concentration greater than about 20% by weight of the starch-based composition, and a fibrous material having an average fiber length greater than about 2 mm and an aspect ratio greater than about 10:1, wherein the fibers are substantially homogeneously dispersed throughout the starch-based composition, wherein the starch-based binder includes a substantially ungelatinized component comprising unmodified starch granules in an amount in a range from about 50% to about 90% by weight of the starch-based binder and a substantially gelatinized component comprising gelatinized starch in an amount in a range from about 10% to about 50% by weight of the starch-based binder prior to molding the composition into the article.

2. A composition as defined in claim 1, wherein the starch-based binder includes a potato starch or a waxy corn starch.

3. A composition as defined in claim 1, wherein the starch-based binder includes a plurality of different kinds of starches.

4. A composition as defined in claim 1, wherein the starch-based binder is included in an mount in a range from about 20% to about 80% by weight of total solids.

5. A composition as defined in claim 1, wherein the starch-based binder is included in an amount in a range from about 40% to about 60% by weight of the total solids.

6. A composition as defined in claim 1, wherein the fibrous material is selected from the group consisting of natural cellulose fibers, glass fibers, synthetic polymer fibers, and mixtures thereof.

7. A composition as defined in claim 1, wherein the fibers have an average diameter in a range from about 10 μm to about 50 μm.

8. A composition as defined in claim 1, wherein the fibrous material is included in an amount in a range from about 1% to about 20% by weight of total solids.

9. A composition as defined in claim 1, further including an inorganic aggregate selected from the group consisting of calcium carbonate, perlite, zeolites, vermiculite, sandstone, glass beads, aerogel, mica, clay, kaolin, gravel, exfoliated rock, derivatives thereof, and mixtures thereof.

10. A composition as defined in claim 9, wherein the inorganic aggregate is included in an mount in a range from about 20% to about 80% by weight of the starch-based composition.

11. A composition as defined in claim 9, wherein the inorganic aggregate includes individual particles having a plurality of different sizes.

12. A composition as defined in claim 11, wherein the sizes of the individual particles are selected to maximize the natural packing density of the inorganic aggregate within the starch-based composition.

13. A composition as defined in claim 12, wherein the sizes of the individual particles are selected so that the natural packing density of the inorganic aggregate is in a range from about 0.5 to about 0.9.

14. A composition as defined in claim 9, wherein the inorganic aggregate has a specific surface area in a range from about 0.1 m^2/g to about 50 m^2/g.

15. A composition as defined in claim 9, wherein the inorganic aggregate has a specific surface area in a range from about 0.2 m^2/g to about 2 m^2/g.

16. A composition as defined in claim 9, wherein the inorganic aggregate is included in an amount sufficient to yield an article having a specific heat in a range from about 0.1 J/g·K to about 400 J/g·K at 20° C.

17. A composition as defined in claim 1, wherein the water has a concentration in a range from about 15% to about 80% by weight.

18. A composition as defined in claim 1, having a viscosity greater than about 10 Pa·s measured at a shear rate of 1 s^{-1}.

19. A composition as defined in claim 1, having a viscosity in a range from about 50 to about 100 Pa·s measured at a shear rate of 1 s^{-1}.

20. A composition as defined in claim 1, having a viscosity in a range from about 200 to about 500 Pa·s measured at a shear rate of 1 s^{-1}.

21. A composition as defined in claim 1, wherein the average fiber length is greater than about 4 mm.

22. A composition as defined in claim 1, wherein the average fiber length is greater than about 8 mm.

23. An inorganically filled starch-based composition for molding into an article, the composition comprising:

(a) a starch-based binder in a concentration greater than about 20% by weight of the starch-based composition, the starch-based binder including a substantially ungelatinized component comprising unmodified starch granules in an amount in a range from about 50% to about 90% by weight of the starch-based binder and a substantially gelatinized component comprising gelatinized starch in an amount in a range from about 10% to about 50% by weight of the starch-based binder prior to molding the composition into the article:

(b) fibers in a concentration greater than about 1% by weight of the starch-based composition and having an average fiber length greater than about 2 mm and an aspect ratio greater than about 10:1, wherein the fibers are substantially homogeneously dispersed throughout the starch-based composition; and

(c) an inorganic aggregate in a concentration greater than about 5% by weight of the starch-based composition.

24. An inorganically filled starch-based composition as defined in claim 23, wherein the fibers have a concentration greater than about 5% by weight of the starch-based composition.

25. An inorganically filled starch-based composition as defined in claim 23, wherein the fibers have a concentration greater than about 10% by weight of the starch-based composition.

26. An inorganically filled starch-based composition as defined in claim 23, wherein the average fiber length is greater than about 4 mm.

27. An inorganically filled starch-based composition as defined in claim 23, wherein the average fiber length is greater than about 8 mm.

28. An inorganically filled starch-based composition as defined in claim 23, wherein the inorganic aggregate is included in an amount greater than about 15% by weight of the starch-based composition.

29. An inorganically filled starch-based composition as defined in claim 23, wherein the inorganic aggregate is included in an amount greater than about 30% by weight of the starch-based composition.

30. A starch-based composition for forming an article of manufacture having a foamed structural matrix, the composition comprising:

(a) a starch-based binder having a concentration of about 20% to about 80% by weight of solids within the starch-based composition;

(b) an inorganic aggregate having a concentration of about 0% to about 80% by weight of solids within the starch-based composition;

(c) a fibrous material having a concentration of about 2% to about 50% by weight of solids within the starch-based composition, said fibrous material having an average fiber length greater than about 2 mm and being substantially uniformly dispersed throughout the starch-based composition; and

(d) water having a concentration of about 15% to about 80% by weight of the starch-based composition;

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wherein the starch-based binder includes a gelatinized component comprising gelatinized starch in an amount from about 5% to about 70% by weight of the starch-based binder, and wherein the balance of the starch-based binder comprises an ungelatinized component comprising ungelatinized, unmodified starch granules prior to forming the composition into an article, wherein said gelatinized component aids in the dispersion of the fibrous material throughout the starch-based composition during mixing.

31. A starch-based moldable mixture for forming an article of manufacture, the moldable mixture comprising water, a starch-based binder in a concentration greater than about 20% by weight, and a fibrous material having an average fiber length greater than about 2 mm, and an aspect ratio of at least about 10:1, wherein the moldable mixture has a viscosity greater than about 10 Pa·s, wherein the starch-based binder includes a gelatinized component comprising gelatinized starch in an amount from about 5% to about 70% by weight of the starch-based binder, and wherein the balance of the starch-based binder comprises an ungelatinized component comprising ungelatinized, unmodified starch granules prior to forming the composition into an article, wherein said gelatinized component aids in the dispersion of the fibrous material throughout the starch-based composition during mixing.

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32. An article of manufacture comprising:

a starch-bound cellular matrix comprising a starch-based binder and fibers dispersed throughout the starch-bound cellular matrix, wherein the starch-bound cellular matrix degrades after prolonged exposure to water; and

a biodegradable coating on at least a portion of the starch-bound cellular matrix.

33. An article of manufacture as defined in claim 32, wherein the biodegradable coating is selected from the group consisting of cellulosic ethers, cellulose acetate, other biodegradable cellulose-based polymer materials, biodegradable polyamides, polyvinyl alcohol, polyvinyl acetate, polylactic acid, polyhydroxybutyrate-hydroxyvalerate copolymer, other biodegradable polyesters, soybean protein, other biodegradable polymers, and mixtures of the foregoing.

34. An article of manufacture as defined in claim 32, wherein the coating is applied to the starch-bound cellular as a liquid which subsequently hardens to form a liquid-tight barrier.

35. An article of manufacture as defined in claim 32, wherein the coating is applied to the starch-bound cellular matrix as a laminating material.

36. An article of manufacture as defined in claim 35, wherein the laminating material is applied in the form of a substantially uniform film.

37. An article of manufacture as defined in claim 35, wherein the laminating material is applied in the form of a sheet.

38. An article of manufacture as defined in claim 32, wherein the starch-bound cellular matrix includes an outer skin portion having a density and an interior foam portion having a density that is significantly lower than the density of the outer skin portion.

39. An article of manufacture as defined in claim 32, wherein the fibers have an aspect ratio greater than about 10:1 and a length greater than about 1.5 mm.

40. An article of manufacture as defined in claim 32, wherein the fibers are included in an amount in a range from about 2% to about 80% by weight of the starch-bound cellular matrix.

41. An article of manufacture as defined in claim 32, wherein the starch-bound cellular matrix has a wall thickness in a range from about 0.5 mm to about 5 mm.

42. An article of manufacture as defined in claim 32, wherein the starch-bound cellular matrix has a wall thickness in a range from about 1 mm to about 3 mm.

43. An article of manufacture as defined in claim 32, wherein the starch-bound cellular matrix further includes an inorganic filler dispersed therein.

44. An article of manufacture as defined in claim 43, wherein the inorganic filler is included in an amount in a range from about 20% to about 90% by weight of the starch-bound cellular matrix.

45. An article of manufacture as defined in claim 32, wherein the starch-bound cellular matrix has a density in a range from about 0.05 g/cm^3 to about 1 g/cm^3.

46. An article of manufacture as defined in claim 32, wherein the starch-bound cellular matrix has a density in a range from about 0.1 g/cm^3 to about 0.5 g/cm^3.

47. An article of manufacture as defined in claim 32, wherein the starch-based binder includes a native starch or starch derivative that has been gelatinized during molding.

48. An article of manufacture comprising:

a starch-bound cellular matrix comprising a starch-based binder and fibers dispersed throughout the starch-bound cellular matrix, wherein the starch-bound cellular matrix has a thickness of less than about 5 mm and degrades after prolonged exposure to water; and

a biodegradable coating on at least a portion of the starch-bound cellular matrix.

49. An article of manufacture as defined in claim 48, wherein the biodegradable coating is selected from the group consisting of cellulosic ethers, cellulose acetate, other biodegradable cellulose-based polymer materials, biodegradable polyamides, polyvinyl alcohol, polyvinyl acetate, polylactic acid, polyhydroxybutyrate-hydroxyvalerate copolymer, other biodegradable polyesters, soybean protein, other biodegradable polymers, and mixtures of the foregoing.

50. An article of manufacture comprising:

a starch-bound cellular matrix comprising a starch-based binder and fibers dispersed throughout the starch-bound cellular matrix, wherein the starch-bound cellular matrix includes an outer skin portion having a density and an interior foam portion having a density that is significantly lower than the

density of the outer skin portion; and

a biodegradable coating on at least a portion of the starch-bound cellular matrix.

51. An article of manufacture as defined in claim 51, wherein the biodegradable coating is selected from the group consisting of cellulosic ethers, cellulose acetate, other biodegradable cellulose-based polymer materials, biodegradable polyamides, polyvinyl alcohol, polyvinyl acetate, polylactic acid, polyhydroxybutyrate-hydroxyvalerate copolymer, other biodegradable polyesters, soybean protein, other biodegradable polymers, and mixtures of the foregoing.

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